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Hippocampal Volumetry among Sudanese Patients attending Elmoalem Hospital, Sudan; structural MRI study (2021-2022)

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Abstract

Background: Hippocampal volume has sharp rise till age of 2 years; then it rises slowly.

Objective: To build a reference for hippocampus volume among Sudanese population.

Method: It was a comparative cross-sectional facility base study; with total coverage of 65 Sudanese patients attending Elmoalem Hospital, for 3D MRI brain, during (December 2021 –April 2022). Dependent variable was hippocampal volume and independent was personal data. Data was collected using master sheet. Measurement was done using 3D slicer program. SPSS version 23 and Chi square test were used. P≤ 0.05 was considered statistically significant.

Results: sixty two percent were female. Minimum age group was up to 18 years while maximum was above 40 years. Total hippocampal volume without gender discrimination was 2118.7370 ± 1081.61581 mm^3; where right hippocampal volume was larger than the left volume. There was no statistical association between hippocampal volume and age group (P value =.994). There was strong statistical association between the male gender and the hippocampal volume, (P value = 0.001). Conclusion: The right hippocampal volume was larger than the left volume. The male's hippocampal volume was larger than female's hippocampal volume. The left hippocampal volume is larger than right one among males. The right hippocampal volume is larger than left one among females.

Keywords: Hippocampal Volume; Gender; Age group; Sudan

1. Introduction

The hippocampus is one of the most thoroughly investigated structures in the brain. It is an elongated structure located medially in the temporal lobe. Its resemblance a seahorse inspired its naming after this sea creature (genus Hippocampus). It's formed by complex bilaminar grey matter and plays an important role in cognition particularly in learning, memory, perception, and regulation of emotional, behavior and certain movements. Recent study shows that the hippocampus can control brain wide functional connectivity in the cerebral cortex and enhance the responsiveness of the brain. In most subjects, the dominant left hippocampus primarily mediates verbal learning and memory, whereas the non dominant right side primarily mediates non verbal memory. [1-10]. The hippocampus volume found to has sharp rise till age of 2 years old; then it rises slowly. Although other studies report decreases in the hippocampus volume in relation to age after the age of 40 years, other studies reported minimal reduction in hippocampus volume in relation

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to age. In correlation with handedness, right lateralization in right-handed people is often reported. Hippocampus volume alterations in relation to gender have no important value in female while in male there is significant right lateralization [9]. Hippocampus has involved in memory functions; CA1 and CA3 subfields contribute to long-term memory while CA3 involved particularly in working and short-term memory. The subiculum which connects the hippocampus to parahippocampal regions has been shown to be keystone in learning and memory [11]. The main role of hippocampus in short and long memory has been a matter of discussion; however, the hippocampal lesion leads to anterograde and retrograde amnesia. Although there is a running argument whether some memory traces are stored in the hippocampus, there is widespread agreement that the hippocampus is required for the formation, consolidation and/or retrieval of semantic, autobiographical, episodic, implicit and procedural memories [11]. Hippocampus play important role in behaviors as well as social interaction, therefore decrease in hippocampus volume is related to various neuropsychiatric diseases, such as depression, schizophrenia, epilepsy, Alzheimer's disease, and sleep disorders. So hippocampus volume needs to be accurately determined, since volume is important in early diagnoses and assessment of treatments [4-8,12-14]. Measurement of hippocampus volume can be through many segmentation techniques using MR sequences, including: visual assessment, linear measurements, manual volumetry, automated volumetry, and signal intensity based scoring and automated method. The gall standard method for evaluation of the hippocampus volume is manual segmentation, although there are no clear protocols that all researchers can apply [5,11,15-17]. Until now there is no reference for the average volume of the human species [18]. Hippocampal volumetric differ greatly between studies, mostly due to the studies inclusion or exclusion of different portions of the HC, i.e., the head, body and tail, Magnetic resonance imaging (MRI) parameters, delineation of structures, and methods of normalization for brain volume are vary among studies. All of these factors may affect volumetric results [12]. The aim of this study was to build a reference for hippocampal volume among Sudanese Population using 3D MRI brain; during (December 2021 –April 2022). However, to my knowledge few was written about hippocampal volume among Sudanese Population, together with lacking of public diagnostic imaging centers along with well trained personnel in Sudan, were the major issues to conduct this study.

2. Material and methods

2.1. Study design

It's an observational comparative cross sectional facility base study**.**

2.2. Study area

Diagnostic Imaging Clinic at Elmoalem Hospital, Khartoum State, Khartoum, Sudan.

2.3. Study population

They are Sudanese patients attending Diagnostic Imaging Clinic at Elmoalem Hospital in the period (December 2021 – April 2022).

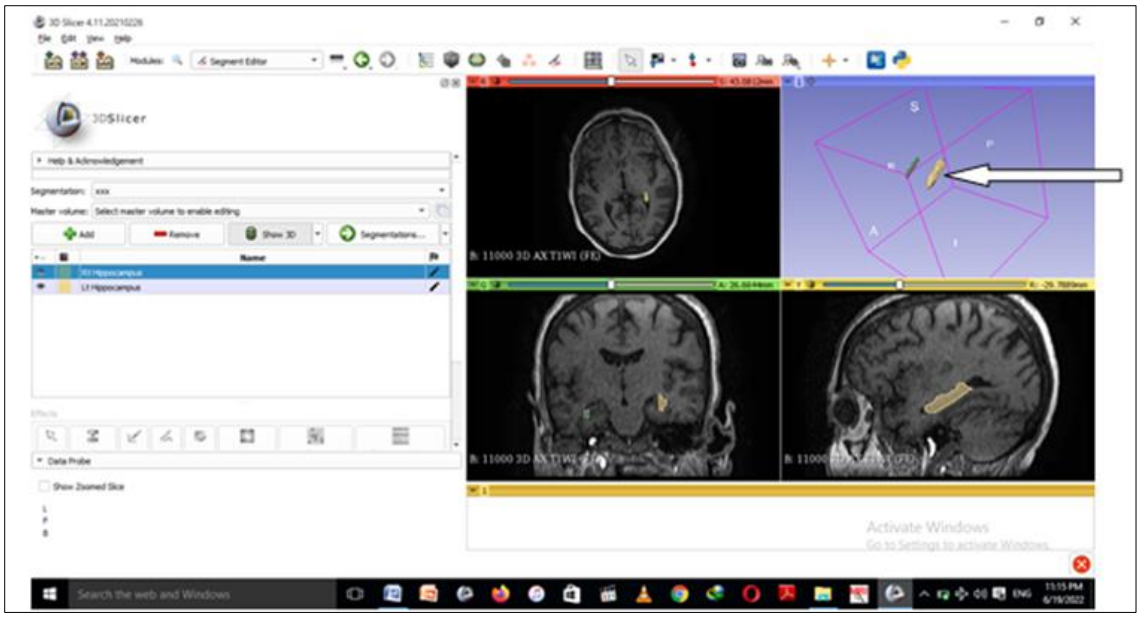
2.4. Sample size

Total coverage of patients attending during this period.

2.5. Data collection tools and management

2.5.1. Data collection tools

Master sheet: composed of socio-demographic data, was used to gather such information from the records of the patients (secondary data). Measuring of hippocampus volume using 3D MRI brain. **Imaging acquisition**: MRI scanner is Toshiba medical system Ventage Elan 1.5 Tesla, 3D MRI scanning slice thickness of 2mm, in axial view. **Software for measurements 3D slicer version (4.11)**: program downloaded from website: www.slicer.org), the National Institutes of Health (NIH) of the USA have been the major contributor, through a variety of competitive grants and contracts.



Source: 3D slicer version(4.11)

Figure 1 Right and left hippocampus on 3D view

2.5.2. Data management and analysis:

Data was processed and analyzed using SPSS version 23. Descriptive data was done. Cross tabulation and Chi-square test were performed. P-value equal or less than 0.05 was considered statistically significant.

2.6. Ethical consideration:

It was obtained from the concerned bodies.

3. Results

The total number surveyed was 65 respondents. Out of them 25 were male and the rest were female. The dominant gender was female (40) followed by male (25), the most dominant age group was above 40 years (67.7%), followed by 19-40 years (24.6%) and the least one was up to 18 years (7.7%).

Table 1 Mean hippocampal volume for age groups, Hippocampal Volumetry among Sudanese Patients attending Elmoalem Hospital, Sudan; Structural MRI study (2021-2022); (n=65)

		Up to 18 yrs	**19-40 yrs**	**Above 40 yrs**
Rt. Volume	Males	1625±185.6	1327±791	1194.5±588
	Females	849±521	954±463	1151±546.8
Lt. Volume	Males	1123±70	1857±1520	1140.7±656.3
	Females	541±284	624±400	828±553

The male's hippocampal volume was larger than female's hippocampus among all age group **(Table 1)**

Table 2 Total, right & left hippocampal volumes, Hippocampal Volumetry among Sudanese Patients attending Elmoalem Hospital, Sudan; Structural MRI study (2021-2022); (n=65)

Hippocampus	N	Minimum	Maximum	Mean	Std. Deviation
Rt volume	65	208.238	2519.030	1148.96518	562.793561
Lt volume	65	143.466	4302.170	969.77186	745.290130
Total HV				2118.7370 ± 1081.61581	

The total hippocampus volume without gender discrimination was 2118.7370 ± 1081.61581 mm^3, the right hippocampus volume was larger the left volume **(Table 2)**

Table 3 Relation between the gender, age group and hippocampus volume, Hippocampal Volumetry among Sudanese Patients attending Elmoalem Hospital, Sudan; Structural MRI study (2021-2022); (n=65)

Gender	Age group			Rt. mean	Lt. mean	Total HV
	0-18	19-40	above 40			
Male	2	6	17	1260.7+/- 614.5	1311.4+/-931.1	6315.13 ± 1348.64
Female	3	10	27	1079.1+/-523.8	756.3+/-506.4	3500.89 ± 765.76075
P Value	0.994			0.000	0.000	

The total hippocampal volume in male was 6315.13 ± 1348.64 mm^3 while in female was 3500.89 ± 765.76075 mm^3. Also, it showed that the male's hippocampus was larger than the female's one, the left hippocampal volume was larger than the right one in male group, while in female the right hippocampal volume was larger than the left one. *P*-Value was statistically insignificant between the hippocampal volume and age group (0.994) of both male and female, while it was statistically significant between the male gender and hippocampal volume (0.000), **(Table 3)**

4. Discussion

Hippocampal volumetry is an area of interest because of its relation with learning, memory and behavior [7,10,11,19]. It's also had role in many neuropsychiatric disorders like: depression, schizophrenia, epilepsy, Alzheimer's disease, and sleep disorders [4-8,12-14].Although many studies tried to evaluate and measure the hippocampus there was no clear reference because of the different approaches[6,8,9,11,13,20-25].In Sudan there was one previous study in this field as far as known [9].According to our result the total hippocampal volume without gender discrimination was 2118.7370 ± 1081.61581 mm^3 this was inconsistent with many international studies [6,8,21,22,25]. The right hippocampus volume without gender discrimination was 1148.96518 ± 562.793561 mm^3 while the left one was 969.77186 ± 745.290130 mm^3 this result was different from other studies [6,8,11,13,20,23-25]. It may be due to genetic, environmental and socio-demographic factors. In relation to gender: the volume in males was found to be 6315.13 ± 1348.64 mm^3 while in females was 3500.89 ± 765.76075 mm^3 this is not similar to other studies [8]. The right hippocampus volume in males was 1260.7 ± 614.5 mm^3 and the left volume was 1311.4 ± 931.1 mm^3 this different from other international studies [8,9]. these variations could be due to the levels of education, nutrition, facilities and qualities of the studies as well as genetic and environmental factors. In females the right hippocampus volume was 1079.1± 523.8 mm^3 and the left volume was 756.3 ± 506.4 mm^3 which was also different from other international studies [8,9]. the possible explanation for such differences in volume could also be due to differences in environmental and socio-demographic factors; as well as the level of education and knowledge as most of these studies were done in Europe. The right hippocampus volume was larger the left volume this was similar to what mentioned globally [23]. The male's hippocampus is larger than female's hippocampus this was consistent with what was reported by other [9,23]. This could be due the high susceptibility of female for emotional distress and depression. Comparing the hippocampus volume between the male and female groups, statistically significant difference was found (p value: 0.000). this similar to was mentioned in other studies [9].

5. Conclusion

As a whole, the right hippocampus volume was larger than the left volume. The male's hippocampus is larger than the female's hippocampus. The left hippocampal volume is larger than the right one among males. The right hippocampal volume is larger than the left one among females. No significant statistical association between hippocampal volume and age group of both genders, while there was significant statistical association between the male gender and hippocampal volume.

Recommendations:

Hippocampal volumetry was recommended to be top priority because of its important aspect as it associated with learning, memory and neuropsychiatric disorders, therefore such researches need to be supported by the government through increasing funds and providing necessary tools like MRI machines, as well as training programs for personnel.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

There is no conflict of interest.

Statement of ethical approval

Ethical approval was obtained from the concerned bodies.

Statement of informed consent

Informed consent was obtained from the Director of the Diagnostic Center at Elmoalem Hospital.

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